ICI MAGAZINE

PRICE TWOPENCE

AUGUST 1958

THE I.C.I. MAGAZINE

VOLUME 36 NUMBER 262 AUGUST 1958

The *I.C.I. Magazine* is published for the interest of all who work in I.C.I., and its contents are contributed largely by people in I.C.I. It is edited by Sir Richard Keane, Bt., and printed at The Kynoch Press, Birmingham, and is published every month by Imperial Chemical Industries Limited, Imperial Chemical House, Millbank, London, S.W.1. Phone: VICtoria 4444. The editor is glad to consider articles for publication, and payment will be made for those accepted.

CONTENTS

Modern Metal in the Making, *by Dorothy Thomas* . 254
People and Events 260
Modern Marvels—The Rocket 266
Winning the Last War, *by James Taylor* . . 268
The Brussels Exhibition, *by Dennis Carey* . . 270
Men with Ideas—George Dale 274
Information Notes:
A Forgotten Pioneer, *by W. H. Cliffe* . . 276
The Future of Titanium, *by Dr. Tom Margerison* 278
News in Pictures 280
Pictures from Overseas 284
Bouncer Makes Three, *by Leslie Way* . . . 286

FRONT COVER: *Village Cricket, by G. F. Allen*

OUR CONTRIBUTORS

Dennis Carey *is a member of European Department, Millbank, and was in Brussels during the first week of the Exhibition. Writing has interested him since he wrote his first article while up at Cambridge: colour photography is a more recent venture. Foreign languages are another of his interests, and he likes to travel and meet the people who speak them.*

Dr. James Taylor *has been Group Director of the Metals and Nobel Divisions since 1952. He was trained as a physicist at Armstrong College in the University of Durham and afterwards at Paris, Utrecht and Cambridge. He joined the Research Department of the Nobel Division at Ardeer in 1928 and became Research Director in 1946 and Managing Director in 1951.*

Dorothy Thomas *is Assistant Public Relations Officer at Metals Division. For several years she was in charge of the Division's Internal Relations and her work brought her into close contact with the* Magazine.

Leslie Way *is Assistant Labour Officer at Steatite and Porcelain Products Ltd., a subsidiary of I.C.I., Metals Division. He is also secretary of the Steatite and Porcelain Recreation Club and a keen member of its Dramatic Society.*

Modern Metal in the Making

By Dorothy Thomas

Illustrated by Arthur Horowicz

This is the story of titanium melting, a process quite unlike the methods traditionally used for casting metal. It has already set the pattern for making other modern metals, such as zirconium for nuclear engineering.

THE staircase is frankly functional. Its three flights rear like scaffolding out of the busy workshop floor, the iron grilles of the treads affording eccentric glimpses of men and machines below.

Three flights up, we step into the cream-painted control room. It is very quiet. A long glass wall deadens the sound of activity below and only a faint hum reminds us that complex instruments are at work behind the lamp-studded panels. A man in a white jacket lifts a welcoming finger but does not turn his head. And immediately our eyes follow his.

He is watching twin screens on which dazzling blue-white half-moons dance and flicker—a picture which tells him that, in a locked cubicle some distance away, a ton of grey powder is changing into molten metal.

This, then, is Metals Division's Titanium Melting Plant, and it is about as different from a traditional casting shop as anything could be. Titanium is in many ways a remarkable metal: in the three years since I.C.I. pioneered its production in Britain it has yielded quite a few surprises. But like a human genius it has its idiosyncrasies, and one of these is that it cannot be turned into massive form by normal casting methods.

To begin with, titanium has a very high melting point—nearly 1700° C., or 200° higher than that of steel. This alone would not be such a problem if, in its molten state, titanium did not combine with the materials normally used to make or line a high-temperature furnace. To make matters worse, molten titanium will absorb gases (oxygen or hydrogen, for instance) which affect its physical properties and so lessen its usefulness as a structural metal.

So before titanium could be tamed some very special plant and techniques had to be devised. The first difficulty—that of the high melting point—was overcome by using the intensely high temperature of a powerful electric arc inside the furnace. The problem of containing the metal while it melted was solved by designing a copper crucible enclosed in a water-cooled jacket, that of contamination by excluding air altogether, melting either in vacuum or in an inert gas.

Although the same basic method is still used, titanium melting today is vastly different from what it was in 1955 when the plant at Witton was commissioned. Then, the size of ingot was limited to 400 lb. in weight and eighteen furnaces were needed for an output of 1500 tons a year. Now, 2000 tons a year can be produced in ingots weighing 2100 lb. or 4200 lb.—and by just three furnaces.

These furnaces, the largest and most up to date in Europe, were built in Western Germany and delivered to Witton early this year. Their installation represented a major achievement for Metals Division engineering services, who had the first one ready for melting a little over two months later—only a year from the time the scheme was first approved.

Because titanium melting is subject to hazards not encountered with more conventional metals, all operations are carried out by remote control. Each furnace is built inside a massive 60 ft. high reinforced concrete cubicle, and before melting starts this is "sealed" by closing and locking a 10-ton door. So that even in an emergency there is no risk to plant personnel.

To initiate melting, an arc is struck between a quantity of titanium and an electrode. The first strange thing we must understand is that the electrode itself is made of titanium—the technical people call it, aptly enough, a consumable electrode, for it is this which melts to form the ingot. So the process of making an ingot begins by forming this electrode from the grey granules of raw metallic titanium (produced by General Chemicals Division), sometimes mixed with other powdered metals to make an alloy.

The electrode can be as much as 12 ft. long and weigh almost a ton. A crane lifts it into a copper crucible which an electrically driven truck carries to the furnace cubicle. When the crucible is clamped into position, pumps begin sucking out contaminating air, creating the vacuum in which melting takes place.

Clinical Precision

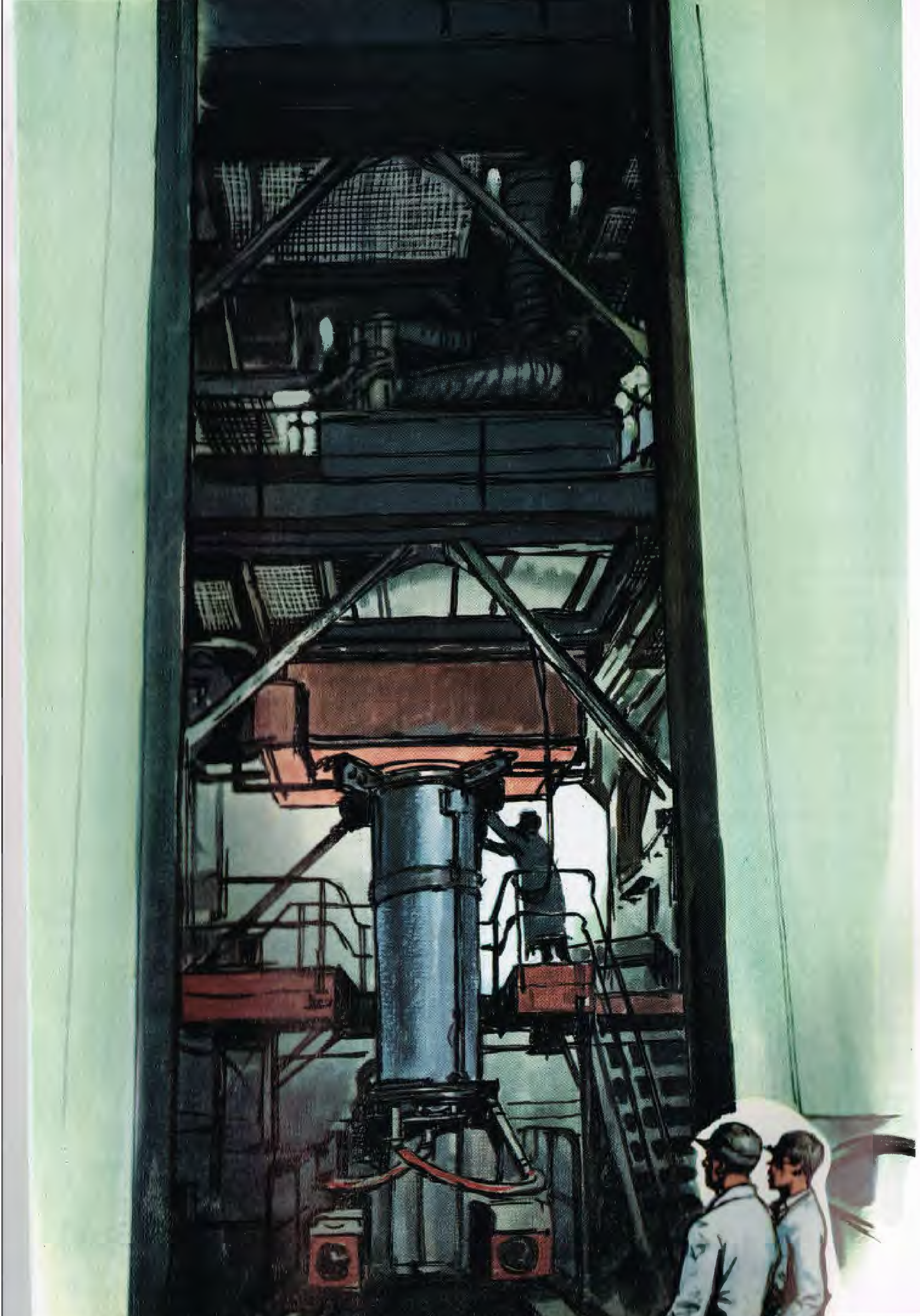
Two men are now working rapidly and skilfully on intricate assembly details. Final dispositions are made with almost clinical precision and in a surprisingly short time the signal is given to clear the cubicle and shut the great door.

Every stage of these preparations is indicated in the control room, where rows of green, orange and red lamps tell the operator that the vacuum inside the furnace is complete, that the ram for lowering the electrode as it melts is in order, that pump mechanisms are all right and that all valves are correctly positioned. A last check by phone confirms that the operator in the control room can now take over and, with a final glance at his battery of dials, he presses the "start" button which sets a powerful electric current flowing inside the furnace.

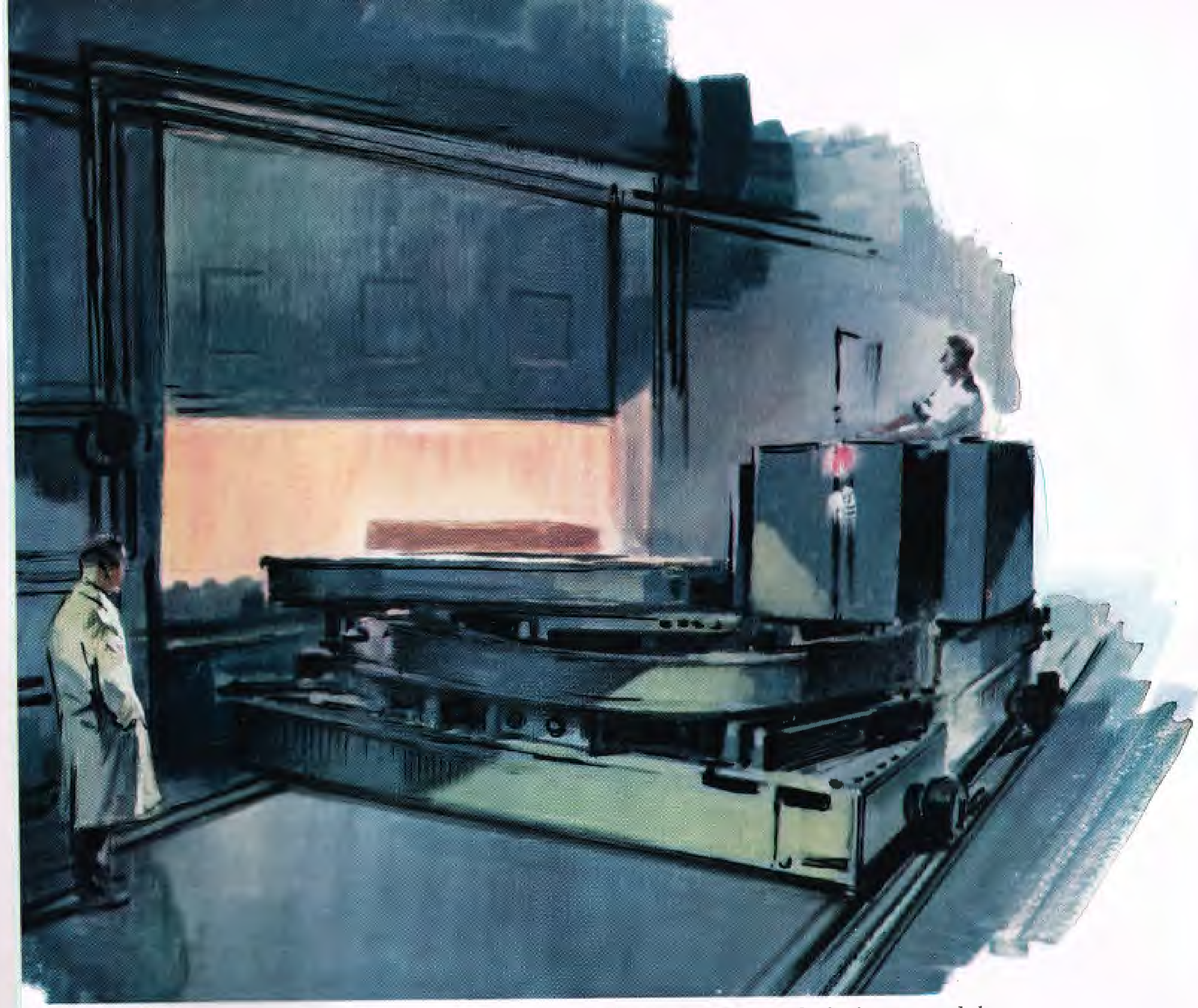
Inside View

With dramatic speed, a picture appears on the screen over the control desk—a brilliant replica of the electric arc now leaping the gap between the electrode and a small heap of titanium in the bottom of the crucible. In the words of the plant manager, the operator now has nothing to do but think—the one thing which this formidable equipment has not yet been trained to do. It will take two or three hours for the 1-ton electrode to melt completely; during this time the operator makes any necessary adjustments to his complicated electric and magnetic circuits and pressure systems, and keeps a watchful eye on the lamps, dials and recording instruments which surround him.

Since we cannot, even for journalistic convenience, force the unhurried pace of the melting process, we must return later to see what happens next. Even then



LEFT: **Fully assembled melting furnace.** *The titanium electrode is now in position inside the furnace and air is being pumped out. When assembly details are completed, the door of the cubicle is closed and melting proceeds by remote control.*
ABOVE: **Forging titanium.** *In the forge, ingots are formed into convenient shapes for further processing. Here the forging press is shaping a flat slab for rolling into sheet.*

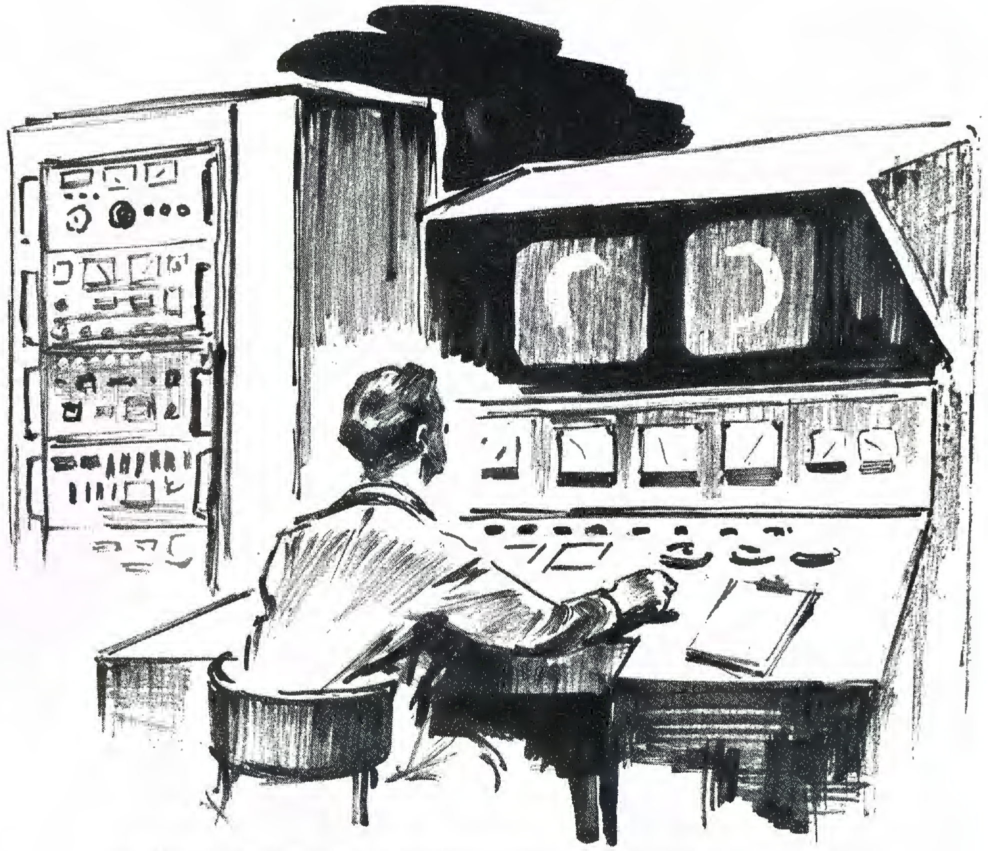


This mobile charging machine *travels between the forging press and the electric furnaces, where ingots are heated to make them soft enough for shaping*

we shall not see the ingot. Titanium is so tricky to handle that, to be on the safe side, it is always melted twice. Until the new furnaces arrived it was necessary to take the first-melt ingot right away before the furnace could be prepared for the second melt. As it had to cool first, this was a time-consuming procedure which greatly interfered with efficient and economic running. Now, however, the hot ingot is simply hauled up out of the way and held, still in vacuum, while the crucibles are changed. The first-melt ingot, now doing duty as the electrode for the second melt, is lowered into the new crucible and the whole cycle can begin again.

From first to last, it will take something like five hours to create our ingot of titanium, and by this time it is, not surprisingly, "too hot to handle." The cooling process begins as soon as the crucible is withdrawn from the furnace, as the truck which carries it out has its own pumping system to keep the water in the crucible jacket circulating.

Observant readers will have noticed that no procedure for testing the quality of the ingot has yet been mentioned. The usual routine of sampling molten metal for chemical analysis would not be practicable for titanium—nor, indeed, is it usually necessary. All that is needed is a check that the ingot is sound. This is normally done by ultrasonic testing, that marvellous eye which can detect the most minute cavity in an ingot weighing nearly a ton.



In the control room. *The electric arc inside the melting furnace is reflected by means of an optical system on to screens above the control desk.*

If the eye approves what it sees, here at last is the end-result of exacting engineering design, of massive machinery and elaborate electrical plant working in intricate harmony, of long experience and highly specialised technical skills. What does it amount to? A cylindrical ingot of silvery metal about the size and shape of a pillar-box. But a very exceptional ingot, for as it stands now on the shop floor it is worth several thousand pounds, and its value will increase at every subsequent stage of the work still to be done on it.

Whatever its future, the ingot will go first to the forge to be formed into a convenient shape for fabrication—flat slab or round billet. From now on the processes it undergoes will be more spectacular if less unconventional. Heated in an ordinary electric furnace, the ingot is pressed and kneaded into shape with astonishing precision by forging press or hammer. Shotblasting or machining peels away the dull outer layer of the forged product, removing any oxygen which might have penetrated the surface, and imparting a silvery sheen which will persist right through the final processes of fabrication into sheet, strip, rod, tube or wire.

Ultrasonic testing. *The soundness of the metal is checked by instruments which can detect the smallest flaw in ingots weighing a ton or more.*

But in spite of its expensiveness and elegant appearance, titanium is not a luxury metal. Although light in weight (only half as heavy as steel) it is very tough indeed, and will stand up to working conditions which would daunt many and sometimes all other structural metals. That is why firms like Rolls-Royce use it for components in their finest engines, why aeroplanes as famous as the P.1, the "Comet" and the "Britannia" testify to its dependability, why chemical engineers are finding in it the answer to some of their most harassing corrosion problems.

Titanium is still a very young metal and many years will pass before its properties and potentialities can be fully exploited. But compared with other twentieth century metals—aluminium, for instance—its progress towards maturity has been extraordinarily rapid. It is stimulating to realise that quite a few of the most significant milestones along this road have been set there by I.C.I.

People and events . . .

Reducing the Barnacle Bill

THE direct cost of fouling on a single voyage from Cape Town to London for a 7500-ton cargo ship capable of 14 knots is about £1200. For the British merchant fleet as a whole, the "barnacle bill" runs into millions of pounds a year.

Playing its part in helping to reduce the bill is the I.C.I. Marine Research Station at Brixham in Devon. The Station is now ten years old, and last month saw the opening by the chairman of the local council, Mr. F. P. Lee, of a new laboratory building on the harbour side.

The new building is among the most up to date of its kind in the world. In the laboratory research workers are able to obtain huge quantities of clean seawater—as much as 20,000 gallons an hour—which is used to carry out experiments to test anti-corrosive paints in constantly flowing seawater.

Floating rafts moored in the outer harbour at Brixham are used for testing the performance of ships' paints for use both above and below the water line. Hundreds of painted panels are either immersed or exposed to wind and weather and salt spray. Similar rafts to those at Brixham are also maintained at Burnham-on-Crouch, Essex.

The new laboratory at Brixham Marine Research Station

Oxford Conference Reunion

NINETY out of the 120 British members who took part in the Duke of Edinburgh's study conference at Oxford two years ago attended a recent week-end reunion held at the Electricity Council's Training Centre at Leatherhead in Surrey. Among them were three of the original I.C.I. conference members, **Mr. W. J. P. M. Garnett**, Plastics Division Personnel Manager, **Mr. W. Heath**, a bag loader at Billingham Factory, and **Mr. E. Garrett**, a fitter at Prudhoe Works. Also present were **Sir Alexander Fleck**, who was chairman at one of the Oxford conference sessions, and **Mr. R. L. Bewick**, assistant Sales Controller (Personnel), who was seconded by I.C.I. to help organise the original Oxford conference.

I.C.I. was asked to undertake the task of organising the reunion, and this was done by Mr. Garnett and a team of five drawn from Plastics Division and Central Labour Department.

The object of the reunion was to bring together again the British members and organising staff of the original conference and to discuss how the spirit engendered at Oxford might be furthered.

The Duke of Edinburgh attended an informal reception on the Saturday evening, where he met all 90 conference members and I.C.I. helpers.

Golden Jubilee

ON 22nd August A.E. & C.I.'s Umbogintwini factory celebrates its golden jubilee. Now it is one of the largest fertilizer works in the southern hemisphere, but it was originally set up to supply explosives for the gold mines.

It was in 1907 that Arthur Chamberlain, chairman of the Birmingham explosives manufacturing company of Kynoch Ltd. and a brother of Joseph Chamberlain, visited South Africa with the object of obtaining contracts with the mining houses for explosives. De Beers (at Somerset West) and Nobel's Explosives Co. (at Modderfontein) were already producing and selling explosives at a lower price than the British-made product could be landed in South Africa. So, backed by his Birmingham board, Arthur Chamberlain acquired the Umbogintwini site near Durban.

Early in 1908 building began on the factory—a 90 tons a week capacity was planned—and on houses for Kynoch's English and Irish staff who were being sent out to manage the new plant.

The switch from explosives to superphosphate took place shortly after the end of the first world war. The changeover was the result of the merger in Britain of Kynoch's and Nobel's Explosives. The decision was made for the two factories in South Africa to concentrate manufacture of explosives for the mines at Modderfontein, sited in the heart of the gold-mining belt, and to develop fertilizers at Umbogintwini. The explosives plant there was finally shut down in 1923.

* * *

Now the factory employs some 770 Europeans and 1500 non-Europeans. Superphosphate is still the main product—last year's output totalled 500,000 tons. In addition, a chlorine plant was completed in 1956 producing about 1200 tons of chlorine and 4000 tons of caustic soda, together with other products, including 'Corvic' and 'Welvic'. The factory also produces animal dips, disinfectants and insecticides.

Armchair Athlete

TAKING a back seat in the literal sense in the ceremony of carrying the Queen's silver baton from Buckingham Palace to the Empire Games last month

was **Mr. Harry Whittle** of Central Work Study Department, who captained the British Olympic Games team at Helsinki in 1952. Mr. Whittle, now retired from active athletics, was clerk of the course, and it was his job to see the baton safely to its destination in the arena at Cardiff, where it was ceremonially handed over to the Duke of Edinburgh. Somewhat to his surprise he found he had been allocated no less than a Rolls-Royce to assist him in his task.

The silver baton contained a message from the Queen to the teams assembled at Cardiff. The journey took four days with a relay of 664 runners. Through Maidenhead it was quite a family affair. The baton was carried in turn by three Paints Division employees, **W. S. Day, V. Hewitt** and **T. Paton,** with Mr. Whittle and the Rolls following on their heels.

Safety Awards

EACH time an I.C.I.A.N.Z. factory reaches 100,000 man-hours without a lost time accident the company pays out a £50 cheque to a charity selected by the works council of the factory earning the award. During the thirteen months the scheme has been in operation £1150 has been paid out to the funds of various charities.

Commenting on the awards made, **Mr. John Pilbeam,** I.C.I.A.N.Z. Safety Officer, said that the prime motive behind the I.C.I.A.N.Z. scheme was of course the safeguarding and protecting of its employees. "But if by working safely we can help some who are less fortunate than we are, it is a worthy aim in itself."

The idea of these awards was adopted by I.C.I.A.N.Z. following a suggestion made at the 1957 I.C.I.A.N.Z. Central Council. So far twenty-three charities have benefited, varying from cancer research to spastic children and the aborigines.

Atom Expert

MR. R. E. Newell, managing director of Wilton Council, flew to Rome last month to advise on the establishment of a nuclear power station in southern Italy. As one of this country's experts on the construction of atomic power projects, he is one of the two British members of a special panel set up by the World Bank. The chairman of the panel is a Canadian, Dr. W. B. Lewis, and there are besides the two British members, two from the U.S.A. and one each from Italy and France. The other British expert is Dr. J. M. Hill of the Atomic Energy Authority.

Mr. R. E. Newell

During the war Mr. Newell was lent by I.C.I. to take charge of the engineering division of the Canadian atomic project which was responsible for building the first atomic reactor outside the United States, at Chalk River, Ontario.

Returning to I.C.I. at Wilton in 1946, he became a consultant to the Atomic Research Establishment at Harwell on possible power developments.

Frau Kraus of Bickford's

A SUCCESS story which must be unique in I.C.I. is that of **Frau Augusta Kraus,** who was recently elected to the supervisory board of Bickford & Co. A.G. (I.C.I.'s Austrian subsidiary) on her retirement as one of that company's joint general managers.

Frau Kraus started her career with Bickford's just after the first world war, when she accepted the chance offer of a job as secretary from Leonard Bickford Smith, who had just returned to Vienna to reopen the family explosives factory there. She recalls that she did not at first like the idea of explosives and quite intended leaving after a few months. But the few months passed, and though after a year or two she married, it was not until her retirement after 36 years' service that she finally said goodbye. During that time she became a well-known and very well loved I.C.I. personality.

Frau A. Kraus

Her greatest contribution to Bickford's came perhaps at the end of the last war, when the Russians overran Vienna and Wiener Neustadt, where Bickford's have their principal factory.

At considerable personal risk, and while sporadic fighting was still going on in the neighbourhood, Frau Kraus and her husband succeeded in getting through to the badly bombed Bickford offices in the Schwartzenbergplatz in the centre of Vienna to retrieve the books and documents which allowed the company to maintain a separate existence.

A few weeks later and Frau Kraus was reassembling staff at Wiener Neustadt and organising a token production in the badly damaged plant. For a part of this time Bickford & Co. had no money in the till, and Frau Kraus and her husband paid the wages out of their own pocket.

During the four-power occupation Wiener Neustadt was under Russian control. Frau Kraus, by now joint general manager, had her full share of the difficulties and played a large part in overcoming them and in building up zip fastener and safety fuse production to the present leading position Bickford's now hold in Austria.

The Open Day Overseas

For the past five years I.C.I. has been holding Work Study Open Days at Head Office for audiences of top management from outside I.C.I. More than 2500 people have attended these meetings, including several Cabinet Ministers. Last month saw the Open Day go overseas—to the Caribbean.

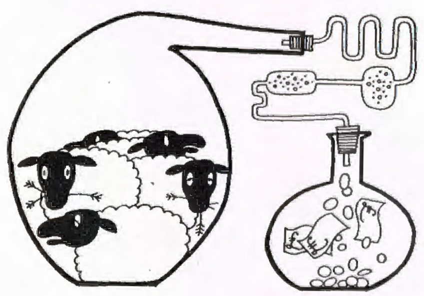
By arrangement with government agencies, a three-man team comprising **Mr. Russell Currie**, head of Central Work Study Department, his deputy, **Mr. J. B. Kitchin**, and **Mr. P. J. Torrie**, who heads the department's training section, spent ten days in the British West Indies giving a high-level survey of the techniques and application of Work Study to representatives of top management in Jamaica and Trinidad.

Bo-peep and All That

Alkali Division recently marketed a new by-product, and, strange as it may seem, the Research and Development people have had nothing at all to do with it. The latest by-product is wool—straight from the sheep's back.

Some time ago it was reported in these columns that the Division had found that by far the most economical way of keeping the grass short on the banks of the limebeds near the Mid-Cheshire works was to rear sheep on them. The Division's flock now totals about 900, divided between limebeds at Winnington, Wallerscote and Lostock, with two full-time shepherds on the payroll to look after them.

Recently it was shearing time, and when the job was completed there was a total clip of $14\frac{1}{2}$ cwt. for sale. This



was packed off to a firm nominated by the Wool Marketing Board, and it has since fetched a price in the region of £330—altogether a most economical proposition.

A Lifetime with Dyes

There can be few people in Britain today who can talk with more authority on the dyestuffs industry than **Mr. Harry Jackson**, joint managing director of the Dyestuffs Division for the past seven years, who has just retired after 45 years' service. His long career with the Company started in 1913 in the dyehouse of Levinstein's, the old-established Blackley dyestuffs manufacturing firm which became a "founder member" of Dyestuffs Division. In those days the dyehouse was a small one-storey building with a stone-flagged floor. Working conditions were primitive, and there was only a handful of "technicians." On his appointment as Chief Colourist eighteen years later he became head of a dyehouse department which had ten sections housed in well-equipped laboratories and a staff of over 200.

In 1939 he moved over to the commercial side. His appointment as Home Sales Manager was soon followed by that of Divisional Commercial Manager, and in 1945 he became Division Director in charge of Home Sales.

Mr. H. Jackson

With his remarkable knowledge of the needs and problems of dyestuffs production and the dye-consuming industries, his advice has been widely sought after in the dyestuffs world. He was a member of the dyestuffs advisory committee to the Board of Trade for eighteen years and was chairman of the dyestuffs committee of the A.B.C.M. A recent appointment was in 1956 as chairman of the trustees of the newly formed Perkin Centenary Trust.

Votes for Polythene

Polythene or polyethylene? Controversy is rife among chemists and others as to which term is the correct one. Polyethylene, which some people are now trying to introduce into this country, is apparently well established on the American scene. But this seems a weak case for adopting it over here—we have not yet rechristened our pavements "sidewalks," and even Doolittle in *My Fair Lady* remains a dustman and not a garbage collector.

Weight of opinion in Britain from I.C.I., who invented it, and the British Plastics Federation, to the housewife shopping for a pail or a washing-up bowl, appears generally in favour of the traditional name polythene.

As **Mr. J. V. Crossley**, Plastics Division Home Sales Director, points out in a letter to *Chemical Age*, the name polythene has never, as some people mistakenly imagine, been the registered trade name of any company but was the first generic name adopted in Britain for high polymers of ethylene. I.C.I. polythene is of course sold under the trade name 'Alkathene.' Polythene is an entirely British invention, and almost all manufacturers in other parts of the world have been, or still are, licensees of I.C.I. It would be a pity, then, if the original name, which is in any case the more attractive, should not continue to be used.

To Boost I.C.I. in India

Mr. Geoffrey Richards, I.C.I.'s Press Officer, has been seconded to I.C.I. (India) to help in setting up a public relations department. He arrived in Calcutta last month and will probably stay for a year or eighteen months. The need for a public relations department in I.C.I. (India) emerged from discussions which Mr. B. W. Galvin Wright, I.C.I. Publicity Controller, had in India earlier this year.

Mr. Richards is no stranger to India. At the beginning of the war he became an officer in the Indian Army. Taken prisoner at the fall of Singapore, he spent $3\frac{1}{2}$ years in a Japanese prison camp. After his release in 1945 he served again in India before being demobilised.

In his absence **Mr. James Thurlby**, who has been a member of the I.C.I. Press Section for the past four years, will act as Press Officer.

Palace Ceremony

One of the first eighteen boys in the country to win the gold standard of the Duke of Edinburgh's Award is 17-year-old **Barry Leslie**, who works in the Paints Distribution Department at Slough. He received the award from the Duke at Buckingham Palace on 4th June. While at the Palace the boys also met Sir John Hunt, who is secretary of the scheme.

Mr. B. Leslie

As part of the test Barry Leslie took part in a three-day expedition covering 60 miles in the Welsh border country living off the land. He also qualified as a first-aider—he holds the adult certificate of the St. John Ambulance Association. He joined I.C.I. in August last year and is a member of Beaconsfield Youth Club.

Another member of the club who won the award was Alan Gwynn, son of **Mr. G. A. Gwynn**, who works in the Research Department at Slough.

NEWS IN BRIEF

Birthday Celebrations. I.C.I. (Chile) celebrated the thirtieth anniversary of its formation with a cocktail party for all its employees. At the party gold watches for 30 years' service were presented to five of the staff.

"Cracker's" First Overhaul. After 20 month's continuous operation the No. 2 Olefine Plant at Wilton has had its first major overhaul. During the shutdown, which lasted a fortnight, every one of its 45 vessels was opened and inspected, together with 40 heat exchangers and 11 distillation columns. At the peak of the shutdown there were 350 men working on the job.

Advance Booking! Nobel Division's Westfalite factory employees have already planned a factory excursion for Whitsun 1959—*My Fair Lady* at Drury Lane and a coach trip to Eastbourne.

Three more reach a Million. Safety bonuses of £100 for completing one million hours worked without a lost time accident have been won by Billingham Research Works, who before the last war were the first Billingham works to win an I.C.I. million-hours shield, by the Services Section of Billingham Engineering Works, and by the Power Electrical, Gas Electrical and Instrument Section of Gas and Power Works.

One per cent 'Terylene.' A speaker at a recent 'Terylene' Works open day pointed out that although 'Terylene' sales last year topped 20 million pounds, this represented only about 1% of nearly 2000 million pounds of natural and synthetic fibre used by the textile trade in 1957.

Umbogintwini First-aiders. All except one of the 31 African and Indian employees who took part in the latest St. John Ambulance course to be run at A.E. & C.I.'s Umbogintwini factory passed the examination. Certificates were presented by the factory manager, Dr. E. H. Flack, at a recent meeting of the African and Indian Works Council.

Motorists' Barbecue. Billingham Synthonia motoring section held their first barbecue on Midsummer Day, but before the 90-odd members could sit down to their camp-fire meal they first had to discover where it was being held. A "treasure hunt" was organised, and to find the barbecue members had to solve clues as they went along.

What's in a Name? Quite a few people rang the bell on the "try your strength" machine at the Wilton Gala, but none so forcibly as one construction works rigger. After several bull's-eyes he gave the button such a blow that the pointer shot up beyond the 14 ft. limit and stuck with the bell ringing continuously. His name? Mr. R. M. Bell!

Billingham win for County. A Billingham factory team, who represented Durham County, won a cup for first place in the scientific reconnaissance test at a Civil Defence competition held at South Shields for teams from the four northern counties and the North Riding.

90-minute Dry Clean. An Adelaide firm of cleaners is now offering a 90-minute service with a new £4000 dry-cleaning machine from Western Germany which does everything but spot and press. The machine uses perchloroethylene made by I.C.I.A.N.Z. at their Botany factory.

Explosion at Tuckingmill. An explosion occurred at Nobel Division's safety fuse factory at Tuckingmill in Cornwall on 18th June. The two workers in the building where the fire started escaped. One of them received slight burns to the legs but was allowed to go home after hospital treatment.

Ardeer Pipers. Ardeer Army Cadet Force pipe band was chosen to play before the Queen and the Duke of Edinburgh at the opening of the Scottish Council of Physical Recreation Centre at Inverclyde, Largs, last month.

Still Digging

Today there is little to tell the visitor that at Vale Royal, headquarters of Salt Division since 1954, once stood one of the greatest Cistercian abbeys in the country, with a church exceeding in length even the vast abbey church of Fountains. As the name implies, it was a royal foundation, being the fulfilment of a vow made by the future Edward I during a stormy voyage in the winter of 1263–64. He laid the foundation stone in 1277, and the monks, a colony from Abbey Dore in Herefordshire, settled at Vale Royal in 1281.

The Black Prince, too, gave the abbey his support, and in 1359 a contract was signed for the construction of twelve chapels at the east end of the church.

The foundations of the abbey church, demolished for building materials after the Reformation, are now buried beneath the smooth lawns surrounding the present nineteenth-century mansion.

In June excavations were begun by

two archaeologists from Chester Museum to try to discover the site of the Black Prince's chapels. So far the curving wall, with buttresses, of what is probably the easternmost chapel has been found together with its stone floor, and one trench has cut into what was evidently the monks' burial ground —the trench contained four skeletons. In the latest trench a silver penny, probably of Henry V's reign, was discovered among the fallen rubble. The excavations continue.

News for Knitters

NEWS for knitting enthusiasts comes from Fibres Division, who announce a new knitting yarn made of 100% 'Terylene.' It is already on sale in two London shops, and other stockists will quickly become available as supplies increase.

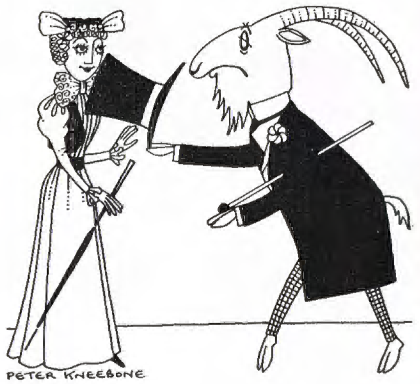
At first "Shawflex," which is made by John Shaw & Sons of Halifax, will be available in 11 shades in three different weights—coarse, medium and fine yarn. The makers claim that 3 oz. of "Shawflex" goes as far as 5 oz. of wool and, as a bigger needle is used (where a size 11 needle is recommended for wool a size 9 needle should be used for "Shawflex"), that knitting time is speeded up.

It can be used for any type of knitting, but because it is shrink proof it is specially recommended for knitteds which need continual washing, such as baby clothes.

Gloucester House Goat

NEWS of the impending move of Southern Region's London staff from Gloucester House to new offices in Holborn has brought forth this story of old Gloucester House from a member of Head Office staff, who gleaned it from his local hairdresser.

Some sixty or so years ago, when Gloucester House was the home of the venerable Duke of Clarence, a magnificent goat was kept in the large stable behind the old house. Why it was kept there no one seems to know. However, the goat was allowed the fullest freedom of movement, and having exhausted the excitement of the old Duke's stables it often used to explore Piccadilly. It would frequently be encountered trotting along towards Bond Street, a lonely aristocratic figure



in the fashion parade with its splendid horns and yellow eyes and one for whom all made way.

Arrived opposite St. James's Street, the goat would pause and survey the scene before it, then cross Piccadilly to the south side and in leisurely fashion retrace its steps to Gloucester House, occasionally stopping to nibble the grass of Green Park through the railings. No one ever attempted to molest it on its excursions!

PEOPLE

Mr. Graeme Stewart (I.C.I.A.N.Z.) took leave of absence to achieve one of his ambitions—to play at Wimbledon. He was defeated by Pimental of Venezuela, 7–5, 6–4, 6–2. Also taking part was **Mr. G. L. Ward** (Head Office), playing in his eighth Wimbledon, who lost to Kurt Nielsen (seeded 6), 6–8, 6–4, 6–4, 8–10, 6–2.

Drum Major **Roy Allan** of the Nobel Division Ardeer Unit, Army Cadet Force, finished equal second when he took part in the world championships at Aberdeen recently. He is the brother of a previous drum major of Ardeer Cadets, Eric Allan, who won the championship three times.

Mr. J. R. A. Glenn, Managing Director of I.C.I.A.N.Z., is one of twenty members of the interim council of the new Monash University appointed by the Australian Government. The first task of the council will be to choose a site for the university.

Edward Bryden, an 18-year-old filing clerk at Trimpell factory, Heysham, and son of **Mr. W. S. Bryden,** nitrates distribution officer at the factory, swam 400 yards out to sea at Heysham on Whit-Monday and saved one of three boys from drowning. The boys, one of whom was drowned, were returning from a trip in their home-made canoe when a large wave overturned them.

Seven employees from Billingham took part in the parade before the Queen in Hyde Park held to mark the fiftieth anniversary of the Territorial Army. They were Messrs. **Taylor, Lockwood, Baker, Jones, Gallogly, Hope** and **Parry.**

Lucky ticket holder among the 2000 visitors who attended the Trimpell Sports Club's first gala day was **Mr. E. Corrin,** a Trimpell laboratory technician, who won a holiday in Paris for two.

Making a comeback into the cycling world, **Jim Turner** (Castner-Kellner Works) recently won the Warrington Road Club's 25-mile event and the 50-mile event and finished fifth in the Anfield "100." His time for this latter tough trial event was 4 hours 27 minutes 41 seconds.

Mr. J. S. Wilcox, Nobel Division Claims Office, has been appointed chairman of Ayrshire Council for Accident Prevention.

Three more Wilton employees have received substantial awards under the Suggestion Scheme. They are **Mr. N. Eadie,** a Plastics Division chargehand on Polythene Works, who has been awarded £500, and two Wilton services organisation chargehands, **Mr. Arthur Ellis** and **Mr. Thomas Hewitson,** who get £350 and £120 respectively.

Former Billingham apprentice plater, **James Rees,** who is doing his National Service in the R.A.F., took part in the Royal Tournament at Olympia as a member of the R.A.F. team putting police dogs through their paces. His father is also an I.C.I. employee—he works as a roof-scaler in the Anhydrite Mine at Billingham.

The new I.C.I.A.N.Z. post-graduate travelling fellowship worth £A1200 has been won by **Mr. E. S. Swinbourne,** a Sydney university chemistry lecturer. He plans to come to Britain to continue research work at University College, London.

Taking part in the opening of Canada's 24th Parliament was **Mr. G. R. Whiston,** industrial sales manager of C.I.L.'s Paints Division. As Honorary A.D.C. to the Governor-General he was among the A.D.C.s who headed the procession as the Governor-General entered the Senate Chamber. He is Lt.-Col. commanding the Canadian Grenadier Guards.

Among 155 drivers from the Birmingham area, all with accident-free records for at least a year, who took part in a "lorry driver of the year" competition were seven Metals Division men. **Mr. J. Caulfield** (Witton) won second prize for vehicles under 15 ft. long, while **Messrs. C. Wigley** (Witton) and **E. Evans** (Summerfield) each won fourth prizes in their class.

Old-established Agents—3

WHEN Denmark began selling bacon to England in the 1880s, Danish demand for pure salt went up. One of the Salt Union's first regular customers was Abels Saltimport of Aalborg, founded by Mr. Andreas Abel in 1871.

Eighty-year-old Mr. Albert Abel, son of the founder, has been in charge of the business since 1907 and must be one of I.C.I.'s oldest agents—in years as well as in the length of his firm's connection with I.C.I. He has outlived many of the people in Salt Division he counted as friends, but remembers quite clearly his visits to Winsford.

Mr. A. Abel

Another agent in Scandinavia who has kindly recollections of Winsford is Mr. Olof Hanson, of the Gothenburg firm of Hanson and Möhring. Hanson and Möhring were in contact with the Salt Union from 1905, and Mr. Hanson's 53 years of personal contacts with the Salt Union and I.C.I. would, he says, yield a bookful of pleasant memories.

Three other salt importers in Scandinavia have long histories of dealing with the Salt Union and I.C.I.: Bröderne Ameln of Stockholm, managed by Mr. Christian Ameln, who is fifth in line of descent from the Christian Ameln who founded the firm; Christianholms Fabrikker of Copenhagen, managed for the last forty years by Mr. Asker Thanlow; and the dairy firm of Flora Danica in Odense.

Shipwreck at Bass Point

A RUSTY metal hulk among the rocks at Bass Point, New South Wales, where I.C.I.A.N.Z. is to build its new £3 million industrial explosives factory, is a mute reminder of a shipwreck that was for six months a wartime secret. Today the wreck sits high and dry at low tide and small boys clamber over it playing pirates. Fifteen years ago men of the Australian militia fought against crashing seas to bring a shipwrecked crew ashore.

On the night of 18th May 1943 an Allied convoy left Sydney Harbour to be met as it left the Heads by a gale which scattered the ships. One of them—a Liberty ship—ran aground at Bass Point. Huge seas, plus the speed of the ship, carried it well up on to the rocks.

At daybreak, with mountainous seas pounding the ship, rescuers went to work to get the crew ashore. They caught lines which were shot from the tanker and then started to haul across the first of the crew by bosun's chair.

All 57 of the crew were saved, but four of the rescuers lost their lives when huge rollers swept them off the rocks and out to sea before anything could be done to save them.

Censorship clamped down on the incident. Bass Point was declared a prohibited zone, and it was not until six months later that the world learned of the shipwreck drama at Bass Point.

Transatlantic Visitor

FOR **Mr. John Gilmour,** one of the 300 visitors at Ardeer factory's last Open Day, a visit not usually included in the Open Day programme was arranged—a call at Misk Farm. He is a member of the last family to live at the farm before it was taken over by Nobel's Explosives Co. early in the first world war.

Mr. Gilmour had not seen the farm for over forty years. He walked through the shell of the buildings and tried the pump in the yard—it no longer works.

He was born in Stevenston, but while still a boy his father, a platelayer at Ardeer, moved into the Misk. There the family of five brothers and a sister grew up, and from there John Gilmour went to Ardeer to learn to be a blacksmith.

With him at Ardeer was his wife, who before her marriage worked in Ardeer Blasting Department. They emigrated in 1922 and settled in Cleveland, Ohio, where Mr. Gilmour worked as a blacksmith until he retired two years ago.

In Scotland they stayed with Mr. Gilmour's brother-in-law, **Mr. James Cramb,** a leading-hand joiner at Ardeer.

Down the Mine

THE way the anhydrite mine's safety achievements encourage greater safety in other mines and quarries in Britain was emphasised by **Mr. W. K. Hall,** Billingham Division Works general manager, when he spoke at a recent dinner for the mine employees. When coal miners visited Billingham they were impressed by the safety methods, he said.

Last year in the mine there were only four lost-time accidents, and the mine is about fifteen times as safe as the average coal mine. At present there are some 270 men employed in the mine, and output this year is expected to reach a million tons.

NEW APPOINTMENTS

Some recent appointments in I.C.I. are: **African Explosives and Chemical Industries Ltd.:** Dr. J. F. Preston (Technical Representative in London). **Alkali Division:** Mr. J. H. Eaden (Safety Officer), Mr. G. S. Couper (General Services Manager), Mr. W. R. Madel (Deputy Winnington Works Manager). **Billingham Division:** Dr. J. G. M. Bremner (Project and Process Research Group Manager), Mr. G. Child (Research Administration Manager), Mr. R. Forth (Sales Control Industrial Products Section Manager), Dr. A. J. Harding (Explanatory Research Group Manager), Dr. J. B. Harding (Research Works Group Manager), Dr. P. G. Harvey (Dowlais Works Manager), Mr. G. H. Payn (Deputy Ammonia Works Manager). **Dyestuffs Division:** Dr. A. K. Gupta (Associate Research Manager). **General Chemicals Division:** Mr. R. B. Peacock (Gaskell-Marsh Works Manager). **Head Office:** Mr. D. G. G. Haffenden (Assistant Secretary), Mr. W. N. Lacon (Registrar). **Heavy Organic Chemicals Division:** Mr. J. S. A. Forsyth (Technical Service and Development Manager), Dr. W. G. Davis (Techno-Commercial Manager). **Metals Division:** Mr. S. M. A. Robinson (Division Assistant Secretary). **Plant Protection Ltd.:** Mr. H. Smith (chairman in addition to his position as Joint Managing Director of G.C.D.). **Plastics Division:** Mr. L. Dobson (Division Engineering Director), Mr. D. W. Ginns (Manager, Engineering Department). **Wilton Works:** Mr. A. W. E. Muir (Supply Manager).

Correction: Mr. C. L. M. Cowley's appointment was incorrectly described in our last issue. He is in fact Joint General Manager of Marston Excelsior Ltd.

THE ROCKET

By G. P. Sillitto (Summerfield Research Station)

Rockets are very much in the news these days. Basically they are of two kinds—those driven by liquid fuels and those driven by a solid fuel. The pros and cons of the two types are here discussed by the head of the Rocket Research Station which I.C.I. operates for the Ministry of Supply.

Illustration by H. J. Eric Smith

ROCKETS are said to have been invented by the Chinese in the Middle Ages. Nevertheless, they are truly a modern marvel, as the artificial satellites now circling the earth show.

All jet propulsion devices—rockets, aircraft turbo-jet engines and ramjet engines—work on the same principle. High-pressure gas in the device is allowed to stream out through a nozzle, forcing the device in the opposite direction. But the three types of jet propulsion device I have mentioned differ in the way the compressed gas is provided.

In the turbo-jet engine the gas is air, drawn in through an engine intake and then compressed partly by means of the compressor in the engine, and partly by burning fuel in it and so raising its temperature, and therefore its pressure, still further.

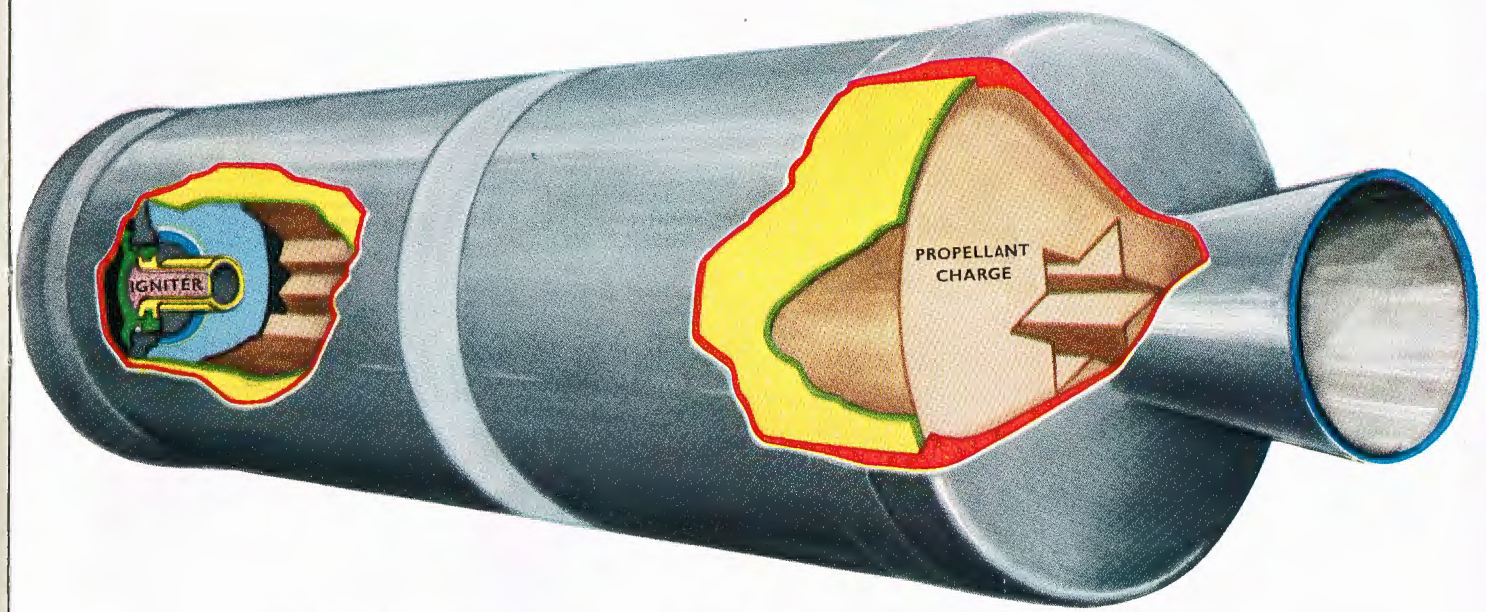
In a ramjet engine the gas is also air, compressed not by a compressor but by the build-up of pressure due to the rapid motion of the engine through the atmosphere; and again heated and compressed further by burning fuel in it.

The rocket motor does not use air. The compressed gas is made by the chemical reaction of solid or liquid substances—called propellants—inside the combustion chamber of the rocket. Since they do not need air, rockets can operate at heights too great for the other kinds of jet propulsion device, or in outer space where there is scarcely any atmosphere. They carry in solid or liquid form every pound of the gas which will issue through their nozzles. They are thus at a disadvantage as far as weight of fuel is concerned, being unable to pick up in the atmosphere any of their issuing gases.

Although at first sight it seems extravagant not to use the air which is freely available except at very high altitudes (where, as we have seen, only rockets can function), it turns out that rockets are not in fact so uneconomical as one might expect, at any rate in "one-shot" devices such as guided missiles. Turbo-jet engines are very expensive things, while ramjets, though cheaper, can only work when travelling at high speed and need to be accelerated up to this speed by means of rockets before they become effective. So there is intense activity in the development of rockets in most of the major countries.

The propellants of rockets can be of two kinds—liquid or solid. During World War II, the German technologists developed large liquid-propellant rockets in a remarkable way and the V2 was the result of these efforts. Since then, the development has been continued in other countries and liquid-propellant rockets have helped to launch the American satellites and probably the Sputniks too.

The propellants used in liquid-fuel rockets can be quite cheap, but the rockets themselves tend to be rather expensive pieces of intricate and high-grade engineering. It is necessary to pump two liquids at accurately controlled rates from their tanks into a specially designed combustion chamber where they react and produce the hot, high-pressure gases. Power to drive the pumps must also be provided; and although the liquids may be cheap, they usually present difficulties in handling or storing, such as corrosiveness, toxicity and fire risk.



Exploded diagram *of a rocket motor, showing the shape to which the solid fuel is cut so that it burns evenly throughout its entire life. The resulting gases are discharged under intense pressure through the nozzle on the right, thus driving the rocket forward in the opposite direction.*

These considerations have led to an interest in solid-propellant rockets; particularly in the direction of making larger and more efficient solid-propellant rockets than had been used up to the end of the last war. Solid-propellant rockets are extremely simple, without any power requirements or moving parts. They consist of little more than a tube strong enough to withstand the gas pressure in which the propellant charge is placed, a nozzle, and an igniter. The solid propellant itself tends to be dearer than some of the liquids which can be used, but this is compensated for by the simplicity, and therefore cheapness and reliability, of the rest of the rocket. Solid-propellant rockets are in fact to be used in one of the very large missiles, the American "Polaris."

The correct functioning of a solid-propellant rocket depends basically upon two things. First of all, the propellant must burn evenly, so that in any small interval of time the same depth is burned off every square inch of its surface. The depth burned off per second depends upon the pressure, but so also does the amount of gas which is discharged through the nozzle, and it is necessary that the rate of increase in the amount of gas being produced, as the pressure rises, should be less than the rate of increase in the amount being discharged through the nozzle. In these circumstances the conditions in the rocket are intrinsically stable, and if for some reason the pressure increases or decreases momentarily, it settles back very quickly to its normal value.

By virtue of these two properties, which in practice amount to finding propellants which burn at a uniform rate when the pressure is constant, and for which the effect of changes in pressure on the rate of burning is fairly small, the basis of design of solid-propellant rockets is the simple one which has been outlined.

Despite their apparent simplicity, there is a great deal that is interesting in the design, manufacture and testing of solid-propellant rockets. High efficiency requires that the case and nozzle should be extremely light and that the propellant composition should deliver as much gas as possible at a very high temperature. Indeed, this temperature is much higher than the melting point of steel. In spite of the enormous energy which it yields when it reacts, the propellant must be stable and safe to handle and store for years in all climates. It must be capable of being made into charges which are entirely free from flaws such as cracks, blowholes and pores, and methods of inspection to verify this must be devised. All these and many other features of work on solid-propellant rockets demand the most up-to-date technical and scientific methods.

Winning the Last War

By James Taylor

Just for the hell of it, an I.C.I. Main Board Director and his son drove 1000 miles over a May week-end (some of it at night) in the 1958 Mobilgas Economy Run. Their calculations proved correct—they won the last war.

I COULD never understand why competent generals invariably fight the last war instead of the present one—I know now because I'm one of them.

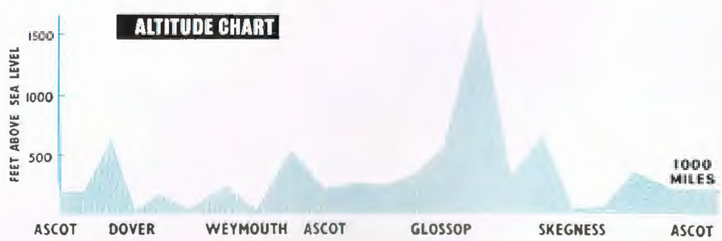
It all started last year when my younger son Rob, with myself as navigator, competed in the *Mobilgas Economy Run* in an Austin A35 and won a second in our class. You ask: "What is an Economy Run?" According to the organisers "Firstly, it is both a test and proof of the economy figures of which normal standard production cars are capable when carefully and skilfully driven at high average speeds along the country's roads. Secondly, it is a test of human ingenuity in using a car, with those careful and skilful handling methods that save fuel and provide figures for comparison by every motorist."

The 1957 event was superbly organised and a good time was had by all, even though it included a night "dice" over the Lake District passes. The second prize whetted our appetites for the 1958 run, so we did our homework during the long winter nights, or rather I did, as Rob was a houseman at the London Hospital on 24-hour call and fully occupied setting up "drips." The 1957 overall winner was the car which achieved the highest ton/miles per gallon (t.m.g.) and the class winners were also selected on t.m.g. figures. For the benefit of mathematicians t.m.g. is (distance/fuel consumed less penalties) × laden weight of car in tons. W. H. G. Kendrick, an economy driver of international reputation, won the event in an Austin A105 with 53·32 t.m.g. and 33·6 m.p.g.

We studied the road tests and specifications of cars and finally came to the conclusion that the Rover 60 with overdrive should be capable of bettering the Austin A105 result. We did not have a Rover 60, but Rob, who hadn't come up the hard way, saw no reason why we should not get one specially for the event—and we did. We reckoned that if we could achieve 32·8 m.p.g. we would beat Kendrick's figure and our tests looked as if we could, so we had the car gone over by experts and got it into first-class trim. Friction was reduced to the minimum. I don't say we got perpetual motion, but we got somewhere near it, and if I quoted the m.p.g. at 35 m.p.h. round a test track you just wouldn't believe me, but it's true!*

When the 1958 regulations came out we got a real setback. Results were to be determined on a basis of *miles per gallon for each class* and the overall winner of the event would be the class winner returning the best t.m.g. figure. At 28 cwt. the Rover didn't stand much of a chance of clocking the best m.p.g. in its class, but it was too late to do anything about it.

We slid off from Ascot with our observer at eleven minutes after midnight, 16th May, on the 1000-mile course. You can see the route in the sketch the artist has provided. Each section had to be completed at an average of 30 m.p.h. It poured with rain all night and in the morning the congestion at Worthing, Southampton and Weymouth was really something.



*Rather more than 40 m.p.g.

High speed and petrol were needed to make up for lost time.

We finished the first run of 466 miles back at Ascot at 7 p.m. and started off again at 6.12 a.m. on Saturday on the 404 miles run to Skegness, taking in Holme Moss and all the moorland and hill terrain between Glossop, Bingley and Castleford *en passant* and consuming petrol at an alarming rate in those crooked hills and vertical villages. On Sunday we set off from Skegness at 6.40 a.m., tiptoed through the tulips of the Fenland and in due course finished the section at Ascot at noon, with one minute to spare.

At 4 p.m. the results were announced. The winner in our class was a Citroën ID19 with 42·56 m.p.g.; the overall winner was a Standard Sportsman with 61·23 t.m.g.

Our results in the Rover were 33·73 m.p.g. and 56·43 t.m.g. We had beaten Kendrick's 1957 record, our calculations had been successful; in fact, we had won the last war.

The Brussels Exhibition

By D. C. P. Carey

Colour photographs by the author

What is the Exhibition like? "I am asked this question over and over again and if I attempted to describe it I would be a hoarse and tired man," says our correspondent. But in fact, in a few hundred words, he manages to convey a most vivid picture of the Exhibition's bewildering array.

THE Brussels Exhibition bristles with superlatives. The Americans love it: the largest number of international exhibitors ever collected on one site, the most aluminium ever used in three-quarters of a square mile, the largest number of Soviet Russians ever to congregate this side of the Iron Curtain, the largest selection of drinks the world has ever offered on one site, the furthest you have ever walked in your life to see the greatest number of objects, the most money you have ever needed to spend so quickly on amusing yourselves.

The Atomium is acknowledged the most ambitious structure built since the Eiffel Tower. The American, French and Russian pavilions are the most expensive pavilions ever put up—the Field of the Cloth of Gold not excluded; and I think that everyone is agreed that the Exhibition as a whole is the most successful and entertaining ever staged.

All this is thanks to the initiative of the Belgians, and praise should not be spared for the way they have succeeded in organising so vast an enterprise. The Belgians have in fact spared neither money nor time in achieving their ambition. This has been to collect together as much of the world's achievement in art and science as can possibly be brought at one time into one place. By doing this they hope among other things to put Brussels on the map to the 30 or 40 million expected visitors, to portray it as the future cultural centre of Western Europe and as the heart of the projected Common Market or Free Trade Area.

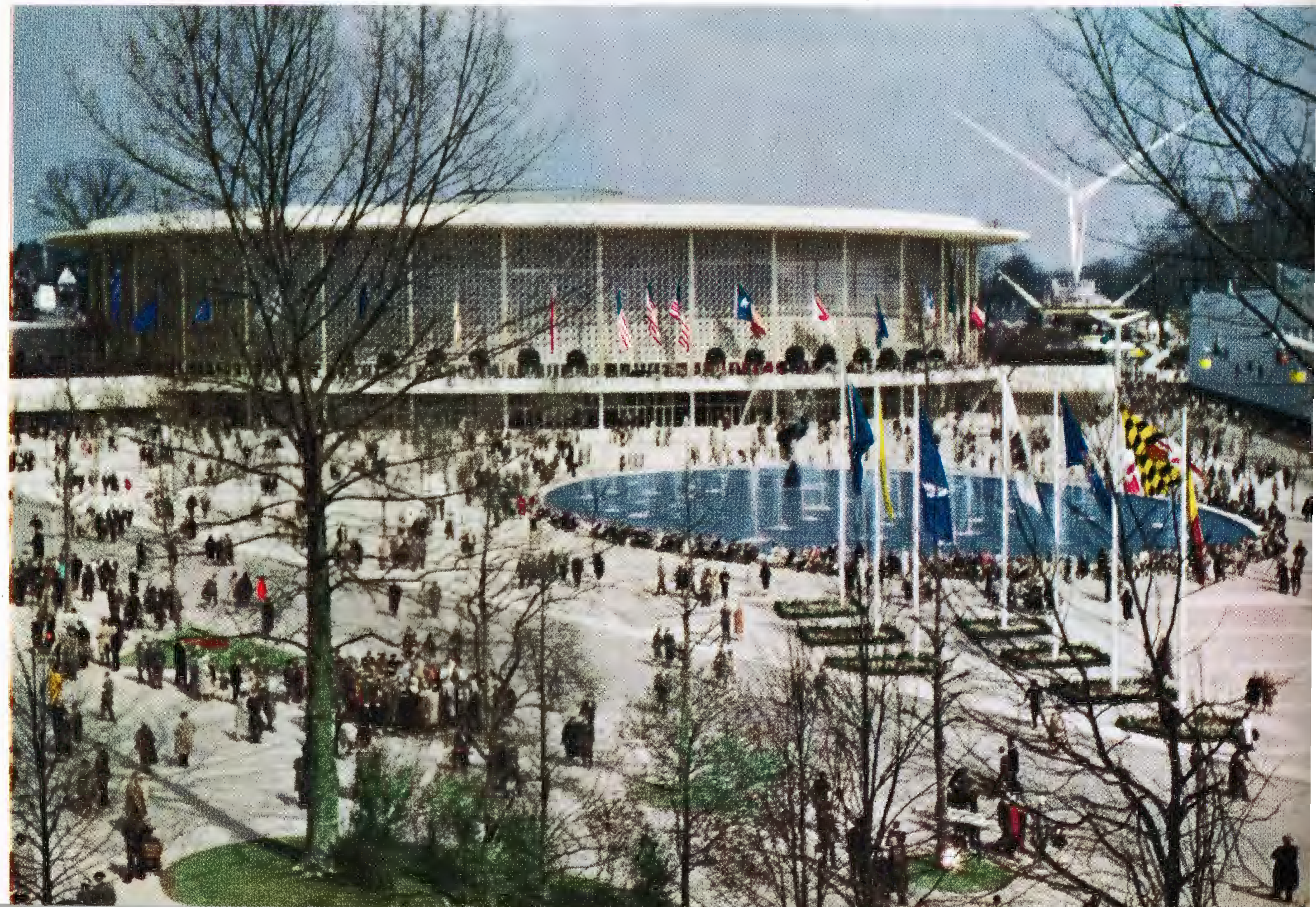
More than £300m. has been spent in preparing the Exhibition site—much more than the total annual budgets of many of the exhibiting countries. Armies of workmen from all nations have pummelled, face-lifted and reshaped the surface of the Park de Heysel outside Brussels and have succeeded in producing a bewildering array of buildings in which every new trick and device of modern architecture has been used, and a good number of old ones too.

At one extreme there is the ultra-modern shape of the French pavilion, the full sweep of its bird-shaped hall too large to be photographed except from the air; at the other there is the traditional temple of Cambodia tucked away in a suitably oriental grove. The British Government pavilion manages to compromise in an excellently successful fashion: with its pyramid shapes and its green, white and purple check exterior it is as revolutionary as any, but inside all is restraint, tradition and British understatement: the total result is reckoned to be one of the successes of the Exhibition.

If you dropped by parachute into the middle of the Exhibition site on a dark night you could well be excused for thinking that you had fallen into the year 1970: indeed, some of the buildings might even make you think still further ahead to 2000.

All around you see a science fiction city of the future: the huge pavilions of the exhibitors seem like great shops and stores crammed with the goods of six continents. Restaurants, cafés, squares with fountains, mosaics, flags and statues, the work of the world's most famous artists. The roads are signposted at every corner, but instead of trams, buses and cars there are overhead cable cars to take you around. Walk a little further and you come across theatres both indoor and open-air, churches Protestant and Catholic, art galleries, formal public gardens, and delightful beech-covered slopes and ravines. A stadium, a helicopter airport . . . there is even the "old city" that every town has tucked away somewhere within itself,

The British Government pavilion *with the Royal Arms, carved in 'Perspex,' at the threshold. The "magicians' hats" have hundreds of tiny windows of stained glass. Below:* **The circular American pavilion,** *large enough to enclose several trees which were already in leaf in April. The fountain forecourt is a popular rendezvous.*



a complete reconstructed eighteenth-century Belgian town. And over all looms the colossal 320 ft. high Atomium with its nine futuristic aluminium balls, which at night flash with lights which are set into their surface and which from a distance make them look like nine whirling incandescent spheres.

The small hours after midnight see the site in the possession of thousands of supply vans, cleaners and maintenance men, the sort of army of unseen night-workers that keep a normal city furbished and in good trim. By nine in the morning all is ready, the pavilion staffs begin to arrive and with them the Exhibition hostesses, some of the most beautiful and intelligent girls in Belgium, specially selected for the job and specially forbidden to accept invitations from the visitors! They are dressed in a plum-red uniform with blue hats and are further equipped with a formidable knowledge of languages. In fact they are only one part of a service that includes thousands of officials, waiters, cooks and staff of every sort, right down to the drivers of the small three-wheeled bicycle rickshaws which serve the elderly or the idle.

Open on time. *Very few exhibitors could make this boast. Bill Marrable, I.C.I. Stand Manager, stands by the "Chemical man" as the clock strikes 10 a.m. on the first morning.*

When the carillon of bells by the Holy See pavilion plays out 10 o'clock all are at their places waiting for the tens of thousands of visitors who swarm in every day (hundreds of thousands at week-ends).

Every nationality imaginable is there. Mexicans confront you on the other side of glass cases; a Malay will sit beside you in a restaurant; Russians, in their ankle-length coats and baggy trousers, are everywhere except in the American pavilion; Americans are lost as likely as not; Germans are taking expert photographs; battalions of Belgians . . . the crowd is just as interesting as the sights they flock to see.

And so we come down to personal opinions. "What was it like?" I am asked time and again. If I attempted to describe it all I would be a weary and hoarse man and I would still leave out the enormous amount that I was unable to see myself and quite a lot of what I did see. All I can say is that there is something for each man's taste. In its 490 acres, its 20 miles of paths and its untold lengths of corridors there are architecture, art, good food and drink, sport, machines and science, the gay lowbrow fun of an evening in the Belgique Joyeuse (the old city), or a more intellectual evening at one of the many theatre performances and concerts; you can have a ride on the téléphérique, a chat with a Czech, or a stare at an African prince—all is variety, and there is no reason why everyone should not enjoy themselves.

The Atomium, *centre of the Brussels Exhibition and 1958's most photographed building. This is one of the rare angles from which all nine spheres can be seen at once.*

Men with Ideas—7

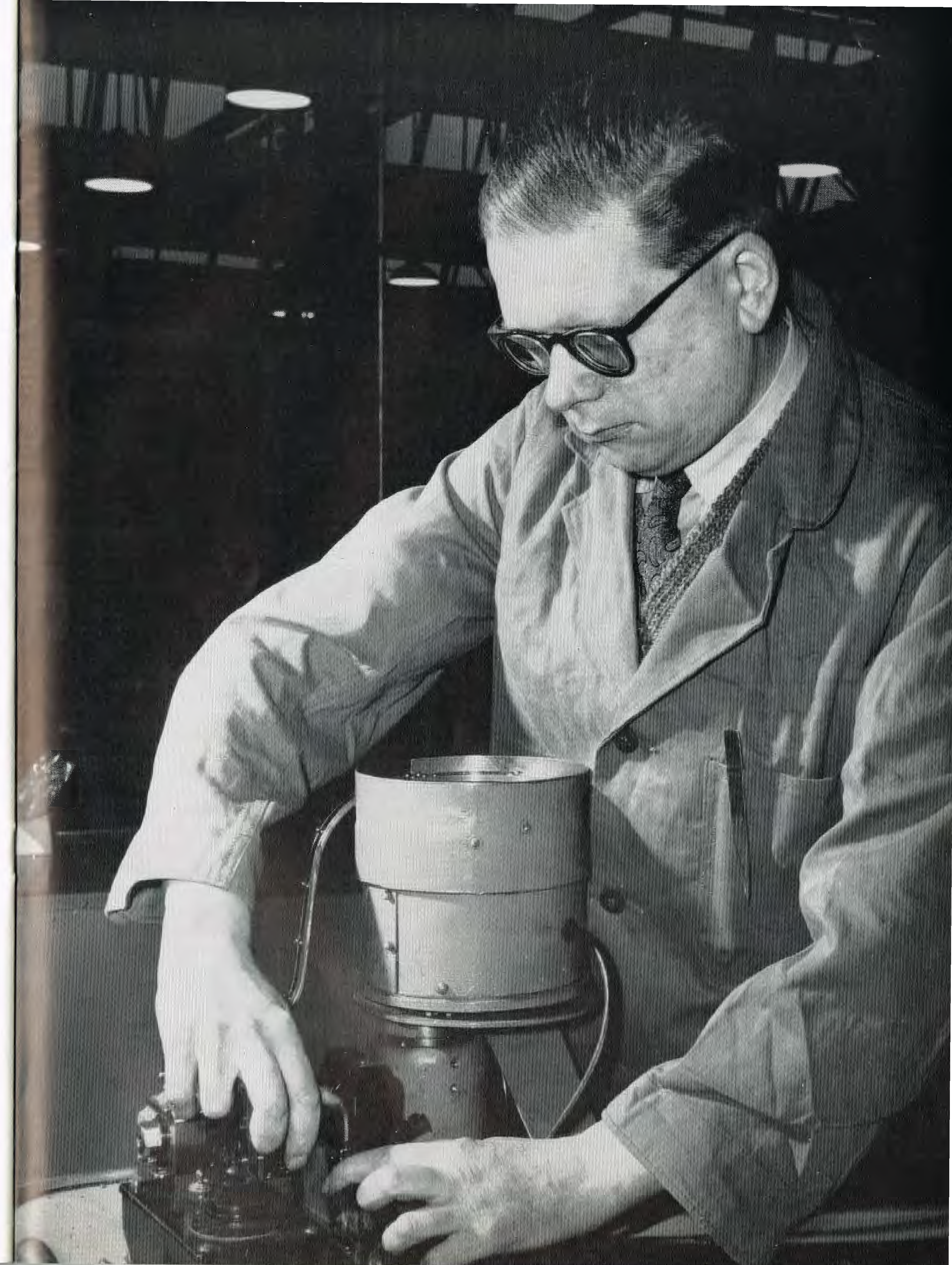
George Dale

NOT all suggestions come into the world fully fledged. The germ of an idea may have to be studied and put into practice by experts—but it's the idea that counts.

George Dale, a toolsetter at the Witton works of Lightning Fasteners Limited, was worried by the amount of scrap that accumulated round the machines which cut zip fasteners to length and attached the stops. He watched lengths being fed in by hand and positioned by an operator who caused the machine to act by depressing a switch with her knee. Could a mechanical operation do the job better, he wondered?

Work study, cost and engineering personnel were called in to discuss his suggestion that a solenoid switch should be introduced which would only operate when the correct length of fastener was accurately positioned. George Dale, of course, took part in the research and development work that followed. When the new mechanism was applied to all the machines there was a considerable saving in labour and raw materials.

George Dale claims to be a very lazy man and says his suggestions are all designed to save trouble for himself and other people. This particular piece of laziness, if you can call it that, won him £300.



A FORGOTTEN PIONEER

By W. H. Cliffe (Dyestuffs Division)

Many if not most of the things we use today owe their colour to azo dyes. Yet the man who discovered them is forgotten. He is Johann Peter Griess, a Prussian, who discovered the azo compounds just 100 years ago—in 1858. Later he emigrated to London and worked at the Royal College of Chemistry and then became chemist to Allsopp's Brewery at Burton-on-Trent.

THE term "azo dyes" may be meaningless to most people, but everyone has seen countless articles coloured with them. Cotton, silk and woollen garments, dresses and scarves of the new man-made fibres, curtains and cushion covers, lipsticks and paints, pictures, plastics and posters—almost anything that has colour can owe its beauty to azo dyes.

Of the many classes of commercial dyes, azo dyes account for about half; in fact, over 1900 azo dyes are listed in the reference books. Yet the man to whom we are indebted for their discovery is almost unknown.

He is Johann Peter Griess, who was born in 1829, was for many years resident in this country, and died in 1888.

Peter Griess was a native of Kirchhosbach in Central Prussia, a tiny village which was almost inaccessible until the spread of rail communications. His father was what we should call a smallholder farmer; he owned and cultivated a little land, he kept the village smithy, and he possessed a small wood from which he cut timber to build his house.

When he was about 15 or 16, Peter Griess was sent to an agricultural school at Beberbeck; and an odd figure he seems to have cut as a rough farmer's boy in both dress and manner. Before long he moved to Cassel, where he entered the Technical High School. He studied hard enough to pass an examination which entitled him to a shorter period of military service than was normal, and so at last he became a Hessian Hussar. But Peter was no soldier, and his father, indulgent as ever, bought him out.

At 21 years of age Peter Griess entered Jena University—an odd thing for a prospective farmer to do, one might think. Probably his father had something to do with this, because Jena incorporated an agricultural college. At the end of the year he left Jena and transferred to the State University of Marburg.

Here he was anything but a model student. He entered fully into the student life, and whenever there was riotous behaviour in the town Griess was sure to be involved. Breaking windows, ringing peals of bells, fighting with night watchmen—nothing came amiss so long as fun was to be had. An occasional night's lodging in the university lock-up did nothing to subdue Griess, but in December of 1853 he was rusticated for breach of the peace. After a year of banishment Griess was allowed to return to Marburg. It does not seem that he mended his ways. Eventually, with one debt added to another and even living in borrowed clothes, he found himself without a roof over his head.

Then came a startling change. He began to study chemistry, secured his first employment, and lost it when the works were burned down. He returned to Marburg a different man. Nothing could distract him from work in the laboratory, and in 1858—just 100 years ago—he published his first paper in a chemical journal. It spread over little more than two pages, but its immediate result was Griess's engagement as assistant to Professor A. W. Hofmann at the Royal College of Chemistry in London.

The important thing about this paper of Griess's is that it announced the discovery of what chemists call "diazo compounds." These very extraordinary compounds are usually violently explosive in the dry state but are perfectly safe when handled as solutions. Not only did Griess first make them known to the world, but he found that they would unite with certain other chemicals to give brilliantly coloured substances which would dye animal fibres. These dyes are the azo dyes which give colour to so many things each one of us handles every day.

Six years before, in 1852, Professor Payen in Paris gave a popular lecture in which he made the ridiculous statement that English brewers increased the bitterness of their pale ale by adding strychnine. Before long all Britain was ablaze with the news, and the widespread alarm seriously affected sales of beer.

The story cannot be told here. All that needs be said is that something had to be done quickly to dispel those damaging rumours, and Allsopp's Brewery at Burton-on-Trent took the first steps. Their chief chemist, Dr. Heinrich Böttinger, collaborated with Hofmann at the Royal College in a series of experiments which showed Payen's statement to be a fabrication. Allsopp's printed hundreds of thousands of copies of the report which cleared their name and distributed them over the whole country. All this was to affect Griess indirectly a few years later. The Royal College of Chemistry earned such a good reputation in Burton that when Böttinger sought for an assistant he found in Griess the right man.

And so, in 1862, Griess went to Burton-on-Trent to learn brewing and fermentation, and the analysis of barley, malt and hops, and to solve the multifarious unexpected problems continually arising in a great brewery. He ultimately succeeded Böttinger as chief chemist and spent the remainder of his life—over 25 years—in the service of Allsopp's. Even so, Griess still found time to investigate his beloved diazo compounds.

Johann Peter Griess. *A photograph taken just before his death and so far unpublished. The original was presented to Dyestuffs Division by his daughter in April 1958.*

One discovery followed another, and his growing collection of chemical samples was a witness to the increasing roll of new azo dyes which his genius brought to light. Others joined in the hunt, and as early as 1884 over 9000 different azo dyes were covered by German patents alone. Yet not one penny piece did they bring to Griess, the originator of them all. He had no technical, as distinct from scientific, gifts and seemed almost unable to comprehend the commercial possibilities of his discoveries. It was others who reaped the benefit.

Not that his work went unnoticed—far from it. He published many papers, and the rewards he received were of the kind he could understand. In 1869 he was admitted to Fellowship of the Royal Society. In 1877 the honorary degree of Doctor of Philosophy was conferred on him by Munich University. He was vice-president of the Chemical Society and of the Society of Chemical Industry, and a founder member of the Institute of Chemistry. He died quietly in his sleep on 30th August 1888 while on holiday in Bournemouth.

One last word. At the age of 40 Griess married Louisa Anna Mason, the daughter of a Burton physician. They had a family of four, two sons and two daughters. One daughter, Mrs. Mary Ard, survives and now lives in British Columbia. In England lives Mrs. Madeline Griess, whose late husband was William Mason Griess, the second son of Peter Griess and for many years Deputy Chief Engineer of the Uganda Railway.

Mrs. Ard and Mrs. Griess have generously presented to the Dyestuffs Division of I.C.I. a few relics of the incomparable Peter, including letters written by him and the certificate of award of his honorary degree at Munich. They will be preserved in memory of Johann Peter Griess, the wild student who became a model citizen of Britain and to whom the chemical industry owes so much.

THE FUTURE OF TITANIUM

By Dr. Tom Margerison

There is optimism about the prospects of this metal. Up to now it has been used almost entirely in aircraft, but its special properties are so attractive that it could have many other uses—and with wider applications its price could be reduced.

Reprinted from "The New Scientist"

ONE of the most exciting developments in metallurgy has been the sudden emergence of an entirely new metal, which a few years ago was no more than a chemical curiosity, to the stage where it is ready for widespread commercial application. The metal is titanium. Ten years ago the world production of titanium was three tons a year; last year more than 25,000 tons were manufactured, the greater part of it in the United States.

The metal was discovered by an English clergyman and mineralogist as long ago as 1791 when he was investigating a black sand found in the Cornish parish of Menachan, but was not prepared in a reasonably pure form until 1925. Even then it was not pure enough for its remarkable mechanical properties to be appreciated.

Titanium owes its present rapid growth to these mechanical properties. Alloyed with small amounts of other metals it is as strong as the best steel, ductile and not subject to fatigue in the same way as aluminium alloys. Most important of all, it is very light. A part made in titanium weighs only a little more than one-half what it would weigh if made of steel. It is, in fact, the aeroplane builder's dream metal, and almost the whole tonnage made so far has been incorporated into aeroplanes.

Weight is at such a premium in an aircraft that one can afford to pay heavily in capital cost in order to obtain a lighter structure, but for other applications price is very much more important. At the moment the one grave disadvantage of titanium is its high price. A part made in titanium costs between six and ten times as much as the same part made in stainless steel, which, of course, is itself many times more expensive than ordinary mild steel. The price of wrought titanium parts of fairly simple form ranges between about £2 10s. and £10 a pound.

In spite of the high price, the demand for titanium from the aircraft industry has been considerable, and titanium plants have been built in the United States, Britain, Japan, France and Germany. However, the demand of the aircraft manufacturers is on the decline, at least for the moment, because of cuts in defence expenditure in Britain and elsewhere.

What is to happen to the new metal? Will it find some other application, or will production remain at the present low level? At the moment the British plant built by Imperial Chemical Industries is working at round about one-tenth of its capacity of 2000 tons a year. Yet, in spite of this, I.C.I. has opened a new titanium rolling plant to make rods and sheets at Waunarlwydd in South Wales. This modern plant, which has cost £3 million, can roll 1500 tons of rod and 300 tons of sheet a year.

This optimism about the future of titanium is based on two premises. First, apart from its lightness and strength, the metal is very resistant to all forms of corrosion—even more so than stainless steel—so that it should have a promising future in the chemical industry. The metal will withstand most corrosives and is particularly resistant to sea water—one of the most corrosive fluids known, particularly when it contains pollutants. Experiments have shown that it would take 4000 years of immersion in sea water under the most unfavourable conditions for a quantity of titanium the thickness of a postage stamp to be dissolved away.

Many possibilities for using titanium pipes and vessels to contain sea water look promising. For example, ships have to make use of sea water to cool the exhaust steam from their turbines in a condenser. The condenser tubes are made of special alloys to resist the action of the sea water, but nevertheless tube failures are common. A condenser made from titanium should last indefinitely. Titanium condensers might also eventually be useful in power stations sited by the sea, which would make use of sea water for cooling.

A recent discovery at I.C.I. Metals Division Research Laboratories extends the range of liquids which do not corrode titanium. The discovery is that titanium can be anodised—that is, given a thicker layer of oxide than normal by means of an electric current—in the same way as aluminium. The anodised surface offers better protection than that given by the thin oxide film which normally covers the surface of the metal.

But, more important, titanium anodises under a very wide range of conditions, and it is a simple matter either by connecting it to an electrical supply or using a small platinum electrode in order to form a kind of "battery" in the corrosive fluid to anodise the titanium *in situ*. If some of the oxide layer becomes dissolved off by the corrosive fluid, then an electric current flows to that part of the titanium and re-forms the layer.

Protected in this way by a constantly re-formed anodic layer, titanium is quite unaffected by such very corrosive liquids as hot sulphuric acid and hot concentrated hydrochloric acid. In fact, the corrosion rate of titanium in hot sulphuric acid is reduced by a factor of 33,000 when this technique is used.

Obviously a metal of this kind is going to be very valuable in the chemical industry, but its usefulness is still directly related to its price. It may be cheaper to use an inferior metal and replace the components more frequently than to use a longer-living component made of a much more expensive material. At the moment the price of titanium is too high to be attractive in many applications, even in the chemical industry.

This brings us to the second premise on which the industry's optimism is based. The producers are convinced that the price can be lowered, if only the vicious circle which links high price with low demand can be broken. I.C.I. estimates that the price could be halved without any technical advance if there were merely sufficient orders to operate the plant at full capacity.

Titanium's high price reflects not only the small scale of production, but the exceptional difficulties of separating it from its ores and melting and forming it subsequently. In some ways the metal is chemically similar to aluminium, since both cling tenaciously to the oxygen with which they are usually combined in their ores. One way of extracting either metal from its oxide is first to make the chloride—a relatively simple job—and then to heat it with a metal which has an even greater affinity for chlorine.

Although many patents have been filed, no practical economic method of separating titanium by electrolysis of the chloride has been devised. One of the reasons for this is that titanium has a very high melting point, whereas aluminium melts at only about 600° C.

It is not practical to operate a bath of molten titanium salt at the temperature of more than 1700° C. which is needed to melt titanium.

The eventual scale of use of the metal is largely bound up with the skill of the designer, because its properties differ so greatly from other metals that entirely different approaches may be necessary. For example, a condenser of the type now used in ships could undoubtedly be built simply by substituting titanium tubes for the present ones. Such a design would work very well but cost a great deal. However, an equally satisfactory solution at much lower cost might be found by using extremely thin titanium sheets in place of the tubes. A design of this sort would corrode away in a short time if made in conventional alloys but would be perfectly sound in titanium.

(Photo: Royal Dutch/Shell Group)
Steel reactor vessel lined throughout with I.C.I. titanium by Marston Excelsior Ltd.

So far designers have not made full use of the opportunities that titanium offers them. Similarly, fabricators have not yet learned the special techniques needed for handling the metal, and hence wastage is higher than it might otherwise be. Since the cost of the metal is so high, it pays to buy parts as near as possible to final size so that a minimum weight of metal has to be machined from them. This is especially true at the moment, since no economic way of reclaiming titanium scrap has yet been found.

Titanium has already found many applications. It is used in the P.1, the Vulcan, the Comet and the Britannia. It is at work in oil refineries and chemical plants. It has even been used successfully for making artificial hips and for hinged finger joints for human beings. It will find many more uses in the future if the metallurgists are right in their belief that the price can be reduced at least to a quarter of its present-day level.

NEWS IN PICTURES

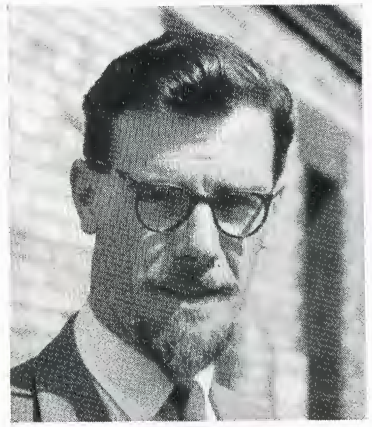
Mrs. Isabel Bond *(Nobel Division), Scottish sprint champion last year, ran for Scotland in the 220 yards at the Empire Games*

Dr. Tom Broadhurst *(Nobel Division), who introduced fencing at Ardeer, was one of the three Nobel Division fencers picked for the Scottish Empire Games team*

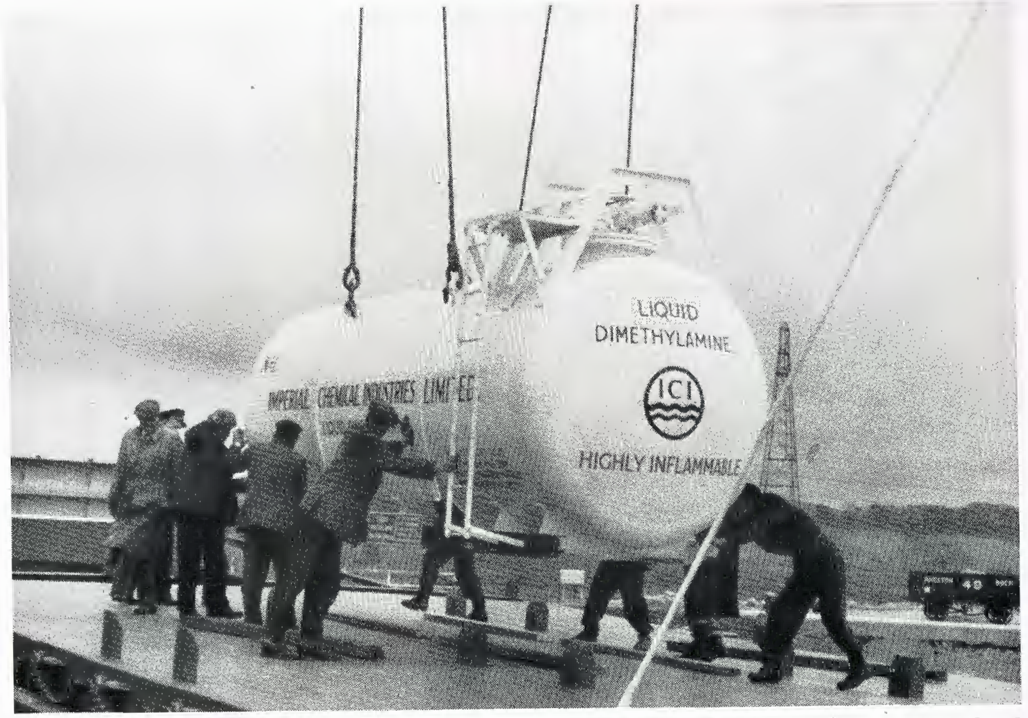
Mr. John Metcalf, *a labour officer at Billingham Factory and an Oxford athletics Blue, was selected for the English team for the 440 yards hurdles*

Mr. Bob Richardson *(Ardeer Research Dept.) was also chosen for the Scottish fencing team. He started fencing under Dr. Broadhurst six years ago*

Churchill College. *Our picture shows Sir Winston Churchill at his London home with fellow trustees of the proposed Churchill College for Cambridge University. The trustees include Sir Alexander Fleck (second from left) and Viscount Chandos (fourth from left). Seated with Sir Winston is Lord Tedder, Chancellor of the University*



Dr. John Tapley, *also of Ardeer Research Department, was the third Nobel Division employee in the Scottish fencing team at the Games*



New bulk load service. *The first bulk shipment of liquid dimethylamine was completed recently by H.O.C. Division when an 8-ton tank was sent from Oil Works, Billingham, by road to Preston and then shipped to the 'Acrilan' acrylic fibre factory at Coleraine in Northern Ireland In the past dimethylamine has been sold in 40-gallon drums*

They fed the 5000. *Sixty members of Wilton catering staff—some of them are pictured above—had a busy day at the works gala. They served 120 gallons of tea, 1000 pies and sausage rolls, 3000 cakes, scores of trifles and jellies, and 1800 children's teas*

Mr. G. D. Hewitt, *who is on the directorate staff of Billingham Division, received the M.B.E. in the Birthday Honours List. He joined I.C.I. in 1927*

Mr. W. H. Hodgetts, *Production Manager of the Copper Products Group of Metals Division, also received the M.B.E. He has been with the Division 32 years*

The secretary of Ardeer Factory savings group, **Mr. James McCauley,** *received his M.B.E. for services to the National Savings movement. He is a costs clerk in the Acids Department*

Mr. C. I. Murray, *who returned from retirement in 1955 to become an apprentice instructor at Wilton Works, received the B.E.M.*

Scooter rally. *Three teams, consisting of six riders from the Motor Cycle and Car Section of Dyestuffs Division's Blackley Recreation Club, received first-class awards in the 24-hour regularity trial at the Isle of Man International Motor Scooter Rally. G. E. Mellor of Pharmaceuticals Division (left), a member of the Bond Minicar and Scooter Club of Great Britain, is seen here at the starting point. (Photo: "Motor Cycling")*

Royal opening. *During her visit to Scotland the Queen formally opened a new national recreation centre at Largs. Above: The Queen with Dr. James Craik, Nobel Division chairman and president of the Scottish Council for Physical Recreation, strolling in the grounds of the centre*

Old soldiers. *Mr. George Wood (Wilton Works) had the honour of handling for the last time the oldest British Legion standard in the country, when it was ceremoniously laid up at Guisborough British Legion headquarters*

Almost 200. *Mr. Sid Sellars has retired after 53 years' service with Lime Division. Between them he and his three brothers have completed nearly 200 years' service*

First lady. *Miss C. E. Summerfield of Casebourne Works is the first woman employee at Billingham Division to complete 40 years with the Company*

Health Minister's tour. *The Minister of Health, Mr. Derek Walker-Smith, recently toured Pharmaceuticals Division's Alderley Park Laboratories and the penicillin plant at Trafford Park Works. Above: He chats with Miss Joan Ogden in the micro-analytical laboratory*

PICTURES FROM OVERSEAS

Belgium. *During his visit to the Brussels Exhibition last month the Duke of Edinburgh was received on the I.C.I. stand by Sir Walter Worboys (Commercial Director). Also seen on the stand are some of the interpreters, and delighted smiles all round seemed to be the order of the day*

Argentina. *Mr. George S. Anderson, P.V.C. Project Manager (seconded from General Chemicals Division), cuts the first turf inaugurating work on Electroclor's new P.V.C. plant at Capitan Bermudez. With him are Señor Silvio Gagliardi (president of Electroclor) and Mr. David Morgan (a director of 'Duperial' Argentina)*

New Zealand. *Our photograph shows a test stack of superphosphate wrapped in 'Visqueen' sheets, which was allowed to weather for six months on an airstrip runway at Tuakau in New Zealand. When opened for loading, the fertilizer was revealed to be in perfect condition*

Spain. *The 'Lightning' Fastener factory at Rubi, 40 miles from Barcelona, belonging to I.C.I.'s representatives in Spain, S.A. Azamón, celebrates its silver jubilee this year. It has a present output of 10 million feet of fastener a year and employs over 400 people*

Nigeria. *A striking photograph of a modern textile mill at Kaduna in Nigeria. The roof is of 'Kynal' corrugated aluminium building sheets (manufactured at Metals Division's Waunarlwydd Works) on an 'Arcon' sawtooth building*

Bouncer Makes Three

By Leslie Way

Illustrated by Martin Aitchison

Some well-meaning friend of ours once presented us with one of those humorous plaques which are hung on a wall for the general merriment of visitors. The message, obviously burnt on with a badly shaped poker, was: "I am the master of my house, so what my wife says shall be done." To those lines should now be added: "Provided Bouncer agrees."

Bouncer is our five-month-old fox terrier puppy. Let's face it, he is the undisputed boss.

We had him at six weeks—a little brown and white bundle of charm who had to be lifted over a step. We bought an assortment of books on how to bring up man's best chum and augmented these with the leaflets of various dog-biscuit manufacturers. The rest was easy. All we had to do was impart the knowledge to our little friend and explain his share in the proceedings.

There were, however, one or two snags. Nowhere in the literature did it offer special instructions for a lithe bundle of quivering muscle with a small head, appealing saucer-like eyes and teeth like an Afghan wolfhound. There were problems such as getting from point A to point B without jeopardising trouser-leg or sock. One must proceed by trial and error, I pointed out to my wife the first time she got bitten.

On one point all the dog books agreed—never smack an offending puppy. There was no need for violence when a few sharp words would do the trick.

My wife reminded me of this as, with a coal shovel, I tried to winkle the miscreant from underneath the settee. This was in regard to a small matter of some teeth marks in my calf. Stern words had failed and the time was ripe for an alternative method of getting the message across. We were discussing the merits of this when the author of the outrage nipped out and bit my thumb and the chap next door thought I had been scalded.

When rearing a dog in the house, certain problems have to be faced, especially when retiring to bed. Admittedly one can lob the pet into the coal shed, slam the door and nip smartly into the house. But that is not for the tender-hearted. Bouncer retired to dreamland in a well-lined box containing a securely wrapped hot-water bottle. This, we calculated, would take the place of his mother. Nearby was his sawdust tray, and over all was cast the flickering light of a candle. For those who are inclined to titter, let it be added that the scheme worked jolly well—peaceful nights were the rule.

One essential thing in rearing a dog is to match cunning with cunning. We found this out the hard way, over the episode of the tablets.

The idea was to grip the animal firmly, open his jaws and pop a tablet down his throat—all simple stuff. Accordingly, I donned a pair of driving gauntlets and after a number of skirmishes the mission was accomplished. The dog was released, his head patted and kind words were uttered. He was so pleased, he poked out his tongue and dropped the tablet on the mat.

The next attempt was a variation on the "Find the Lady" system. Eight choice pieces of meat were quickly juggled and fed into the eager jaws. True to form the meat swiftly disappeared and the tablet, which had been cunningly concealed in piece seven, landed back on the mat.

. . . I had him back by stealing his bone and tantalising him through the sitting-room window

Prompted by feminine sniggers and incensed by the smug look on the dog's face, I devised the master plan. As a gesture to fellow men I now give the details without any thought of royalties or monetary gain. All you have to do is to enter the room whistling a merry tune—any old tune will do. Ignore the dog. Pull out a handkerchief and the tablet accidentally drops out and rolls across the carpet. Utter a sharp cry and chase after it. The dog gets there first, seizes the tablet and legs it for cover. Demand the instant return of the tablet as being your rightful property and the episode is concluded in one gulp.

One need not dwell too long on the need for correct training of a dog. There can be few more pleasant sights than that of a well-trained animal trotting obediently at his master's heel. So far, I've hardly been able to get Bouncer as far as the front gate according to plan. So the battle goes on—first this way, then that. The other day he sneaked my under-trousers while I was in the bath and trotted off triumphantly down the garden. I had him back by stealing his bone and tantalising him through the sitting-room window.

There is one black cloud on the horizon. For some time past Bouncer has been shedding his milk teeth. They have been replaced by an alarming array of carnivorous choppers, crushers and grinders. These he is already able to "clack" in threatening fashion. Sharp nips are a thing of the past—it is now a matter of first aid. In the battles that lie ahead, wish me luck—I feel that I'm going to need it.

"The Mirror" Photo by David Hopewell (The Kynoch Press)